REMARKS

Claims 1-6, 12-13 and 18-33 are pending in this application. By this Amendment, claims 27-33 are newly added. Support for the new claims can be found in the original specification at, for example, Figs. 1-3 and page 11, lines 1-21. No new matter is added.

In view of the foregoing amendments and the following remarks, reconsideration and allowance of claims 1-6, 12-13 and 18-33 are respectfully requested.

35 U.S.C. §103(a) Rejections

Nikolaev In View Of Benander

Claims 1, 3, 18-19 and 23 were rejected under 35 U.S.C. §103(a) as allegedly being obvious over Nikolaev (U.S. Patent No. 6,218,269) in view of Benander (U.S. Patent No. 4,698,244). Applicants respectfully traverse this rejection.

Claim 1 requires a method for growing an Al-containing III-V group compound semiconductor by vapor phase epitaxy in a reaction chamber made at least of quartz material, wherein a first step in the method comprises reacting a solid Al with a halogenated hydrogen at a temperature of from 300°C to 650°C to produce a halogenated product of Al, wherein the first step occurs in a first reaction zone of the reaction chamber.

Nikolaev describes that "the substrates were heated in Ar flow up to growth temperature and the metals were heated up to temperatures ranged from 350 to 800°C. HCl gas (tank of HCl gas was used for HCl supply) was introduced in the source zone (in Ga channel in case of GaN growth, and in both Al and Ga channels in case of AlGaN alloy growth). As a result of reaction between HCl and Ga (Al), gallium chloride (aluminum trichloride) was formed and delivered to the growth zone by Ar flow." See col. 7, line 64 to col. 8, line 7 of Nikolaev.

However, Nikolaev does not describe or provide any reason or rationale for one of ordinary skill in the art to have come to reacting a solid Al with a halogenated hydrogen at a

temperature of from 300°C to 650°C to produce a halogenated product of Al in a reaction chamber comprised at least of quartz material. Nikolaev fails to describe the unexpected advantages associated with this reaction temperature in a reaction chamber comprised at least of quartz material. The evidence of unexpected results has been discussed throughout prosecution, and is further discussed below.

The data from the experiments in the Rule 132 Declaration ("132 Dec.") submitted herewith demonstrate the unexpected results achieved in reacting a solid Al with a halogenated hydrogen at a temperature of 300°C to 650°C in a first reaction zone of the reaction chamber, which is made solely of quartz, during the first step of the reaction. By reacting a solid Al with a halogenated hydrogen at a temperature of no more than 650°C in the first reaction zone, an Al component such as $AlCl_3$ formed in the first reaction zone is transported into the second reaction zone and prevents the quartz reaction tube of the second reaction zone from being corroded, damaged or discolored by the Al component therein.

As illustrated in the 132 Dec., the temperature range of 300°C to 650°C is critical to preventing the quartz reaction tube from being corroded, damaged or discolored. As illustrated in Figs. 1A and 1B, the quartz tube is completely transparent after conducting the experiment at 650°C, the upper end of temperature range of claim 1, and thus the quartz tube is not contaminated.

However, Figs. 2A-7A and 2B-4B and 7B each illustrate that the quartz tube turns a progressively darker "charcoal color" when the reaction is conducted at temperatures above 650°C, temperatures above those claimed in claim 1, indicating that the quartz reaction tube has become contaminated during the reaction with halogenated hydrogen and Al. As illustrated in the Figs. 2A-7A and 2B-4B and 7B, the amount of contamination increases with a corresponding increase in temperature above 650°C.

Thus, the results illustrated in the 132 Dec. clearly show that reacting a solid Al with a halogenated hydrogen at a temperature of 650°C or less in a first reaction zone of the reaction chamber unexpectedly prevents the quartz reaction tube from becoming corroded, damaged or discolored, and thus results in a superior semiconductor product.

Benander does not remedy the deficiencies of Nikolaev. Benander describes a method of producing a titanium aluminide coating on a substrate. See the Abstract of Benander. The Patent Office alleges that Benander describes a reaction of aluminum and hydrogen chloride at 500°C and it thus allegedly would have been obvious to have modified Nikolaev to use a temperature of 500°C. However, Benander describes a process for making titanium aluminide (TiAl), not a Group III-V compound. Further, the reaction referenced in Example 1 of Benander takes place in a pot 39 (see Figure 1), not a quartz reaction tube. Benander does not describe the production of AlCl with respect to the use of a quartz reaction chamber, nor does Benander describe any advantages to avoiding the production of AlCl by maintaining a temperature of 300°C to 650°C while reacting a solid Al-containing compound and a halogenated hydrogen, as required by claim 1.

Thus, for at least the above reasons, the combination of Nikolaev and Benander do not describe, or provide any reason or rationale for one of ordinary skill in the art to have come to, a method for growing an Al-containing III-V group compound semiconductor by vapor phase epitaxy in a reaction chamber made at least of quartz material, wherein a first step in the method comprises reacting a solid Al with a halogenated hydrogen at a temperature of from 300°C to 650°C to produce a halogenated product of Al, wherein the first step occurs in a first reaction zone of the reaction chamber.

Withdrawal of the rejection is respectfully requested.

Nikolaev In View Of Benander In Further View Of Shibata And Vaudo

Claims 4, 6, 21 and 24 were rejected under 35 U.S.C. §103(a) as allegedly being obvious over Nikolaev in view of Benander and in further view of Shibata (EP 184488) and Vaudo (U.S. Patent No. 6,533,874). Applicants respectfully traverse this rejection.

Claim 4, similar to claim 1, requires a first step of reacting a solid Al with a halogenated hydrogen at a temperature of from 300°C to 650°C to produce an halogenated product of Al.

As described above, the combination of Nikolaev and Benander do not render obvious at least the feature of reacting a solid Al with a halogenated hydrogen at a temperature of from 300°C to 650°C to produce an halogenated product of Al.

Shibata and Vaudo also fail to describe, or provide any reason or rationale for one of ordinary skill in the art to have come to, a method for producing an Al-containing III-V group compound semiconductor in a reaction chamber made at least of quartz material, wherein the method includes a first step of reacting a solid Al with a halogenated hydrogen at a temperature of 300°C to 650°C to produce a halogenated product of Al, as recited in claim 4.

Withdrawal of the rejection is respectfully requested.

Nikolaev In View Of Benander In Further View Of Solomon

Claims 2, 12, 20 and 25 were rejected under 35 U.S.C. §103(a) as allegedly being obvious over Nikolaev in view of Benander and in further view of Solomon (WO 00/68470). Applicants respectfully traverse this rejection.

Similar to claim 1, claim 2 requires a first step of reacting a solid mixture of group III metals including Al with a halogenated hydrogen at a temperature of from 300°C to 650°C to produce a halogenated product of group III. No combination of the cited references renders at least this feature of claim 2 obvious.

Solomon also fails to describe, or provide any reason or rationale for one of ordinary skill in the art to have come to, a method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy in a reaction chamber made at least of quartz material that includes a first step of reacting a solid mixture of group III metals including Al with a halogenated hydrogen at a temperature of 300°C to 650°C to produce a halogenated product of group III, as recited in claim 2. Thus, Solomon does not remedy the deficiencies of Nikolaev and Benander.

Withdrawal of the rejection is respectfully requested.

Nikolaev In View Of Benander In Further View Of Solomon, Shibata and Vaudo

Claims 5, 13, 22 and 26 were rejected under 35 U.S.C. §103(a) as allegedly being obvious over Nikolaev in view of Benander and in further view of Solomon and even in further view of Shibata and Vaudo. Applicants respectfully traverse this rejection.

Similar to claim 1, claim 5 requires a first step of reacting a solid mixture of group III metals including Al with a halogenated hydrogen at a temperature of from 300°C to 650°C to produce a halogenated product of Al.

As discussed above, no combination of Nikolaev, Benander, Solomon, Shibata and Vaudo render at least this feature of claim 5 obvious. Withdrawal of the rejection is respectfully requested.

New Claims

New claims 27 and 29-31 require: (1) that the partial pressure of the halogenated hydrogen in the first reaction zone is in the range of about $1x10^{-5}$ to $5x10^{-2}$ atm, and (2) that the gas containing a group V element is under temperature and pressure conditions in the second step such that the partial pressure of the gas containing a group V element is in the range from about $2x10^{-5}$ to about $5x10^{-1}$ atm.

None of the cited references describe, or provide any reason or rationale for one of ordinary skill in the art to have come to, using the partial pressure of the halogenated hydrogen in the first reaction zone in the range of about $1x10^{-5}$ to $5x10^{-2}$ atm and the partial pressure of the gas containing a group V element in the range from about $2x10^{-5}$ to about $5x10^{-1}$ atm.

Claim 32 requires that the halogenated product of Al is $AlCl_3$ and the gas containing group V element is NH_3. None of the cited references, alone or in combination, render at least this feature of claim 32 obvious.

Claim 33 requires that the second step of reacting the halogenated product of Al produced in the first step with a gas containing a group V element is conducted at a temperature greater than 900°C. None of the cited references, alone or in combination, render at least this feature of claim 33 obvious.

Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-6, 12-13 and 18-33 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Andrew B. Whitehead
Registration No. 61,989

JAO:ABW/tca

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OLIFF & BERRIDGE, PLC
P.O. Box 320850
Alexandria, Virginia 22320-4850
Telephone: (703) 836-6400

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